EXHIBIT R

A Simplified Guide to Fingerprint Analysis,
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A Simplified Guide To

Fingerprint Analysis

Introduction

We touch things every day: a coffee cup, a car door, a computer keyboard. Each time we do, it is likely that we leave behind our unique signature—in our fingerprints.

No two people have exactly the same fingerprints. Even identical twins, with identical DNA, have different fingerprints. This uniqueness allows fingerprints to be used in all sorts of ways, including for background checks, biometric security, mass disaster identification, and of course, in criminal situations.

Fingerprint analysis has been used to identify suspects and solve crimes for more than 100 years, and it remains an extremely valuable tool for law enforcement. One of the most important uses for fingerprints is to help investigators link one crime scene to another involving the same person. Fingerprint identification also helps investigators to track a criminal's record, their previous arrests and convictions, to aid in sentencing, probation, parole and pardoning decisions.

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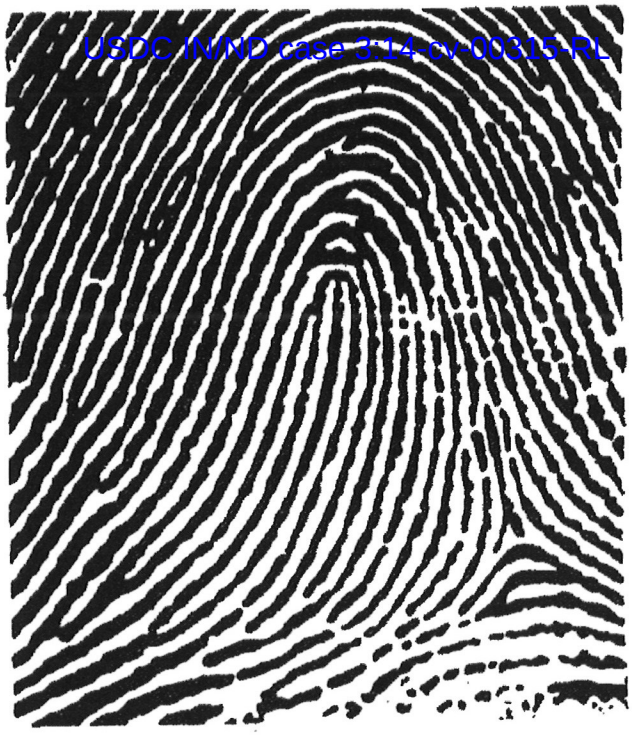
Principles of Fingerprint Analysis

Fingerprints are unique patterns, made by friction ridges (raised) and furrows (recessed), which appear on the pads of the fingers and thumbs. Prints from palms, toes and feet are also unique; however, these are used less often for identification, so this guide focuses on prints from the fingers and thumbs.

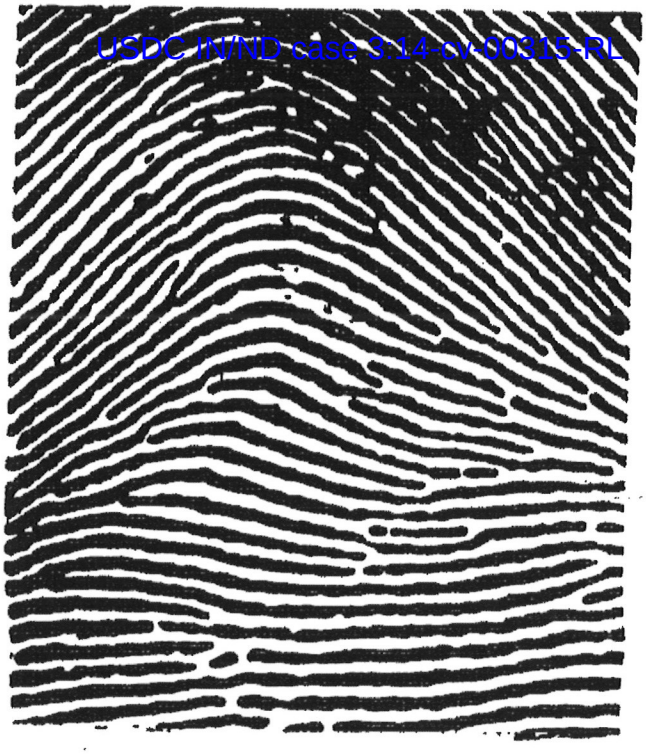
The fingerprint pattern, such as the print left when an inked finger is pressed onto paper, is that of the friction ridges on that particular finger. Friction ridge patterns are grouped into three distinct types—loops, whorls, and arches—each with unique variations, depending on the shape and relationship of the ridges:

Loops - prints that recurve back on themselves to form a loop shape. Divided into radial loops (pointing toward the radius bone, or thumb) and ulnar loops (pointing toward the ulna bone, or pinky), loops account for approximately 60 percent of pattern types.



Whorls - form circular or spiral patterns, like tiny whirlpools. There are four groups of whorls: plain (concentric circles), central pocket loop (a loop with a whorl at the end), double loop (two loops that create an S-like pattern) and accidental loop (irregular shaped). Whorls make up about 35 percent of pattern types.

Arches - create a wave-like pattern and include plain arches and tented arches. Tented arches rise to a sharper point than plain arches. Arches make up about five percent of all pattern types.



To Each His Own

The two underlying premises of fingerprint identification are uniqueness and persistence (permanence). To date, no two people have ever been found to have the same fingerprints—including identical twins. In addition, no single person has ever been found to have the same fingerprint on multiple fingers.

Persistence, also referred to as permanence, is the principle that a person's fingerprints remain essentially unchanged throughout their lifetime. As new skin cells form, they remain cemented in the existing friction ridge and furrow pattern. In fact, many people have conducted research that confirms this persistency by recording the same fingerprints over decades and observing that the features remain the same. Even attempts to remove or damage one's fingerprints will be thwarted when the new skin grows, unless the damage is extremely deep, in which case, the new arrangement caused by the damage will now persist and is also unique.

The Proof is in the Minutiae

Analysts use the general pattern type (loop, whorl or arch) to make initial comparisons and include or exclude a known fingerprint from further analysis. To match a print, the analyst uses the minutiae, or ridge characteristics, to identify specific points on a suspect fingerprint with the same information in a known fingerprint. For example, an analyst comparing a crime scene print

to a print on file would first gather known prints with the same general pattern type, then using a loupe, compare the prints side-by-side to identify specific information within the minutiae that match. If enough details correlate, the fingerprints are determined to be from the same person.

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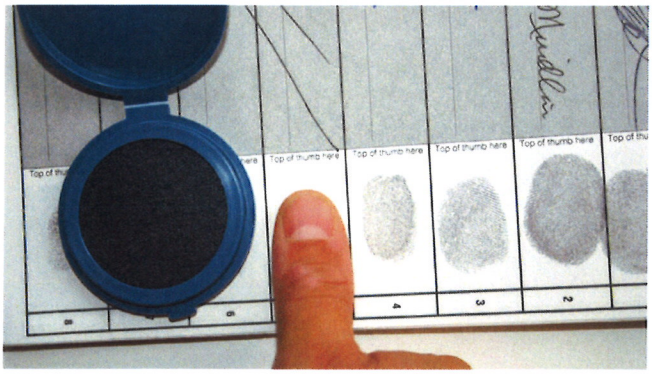
When and when is fingerprint analysis used?

Fingerprints can be used in all sorts of ways:

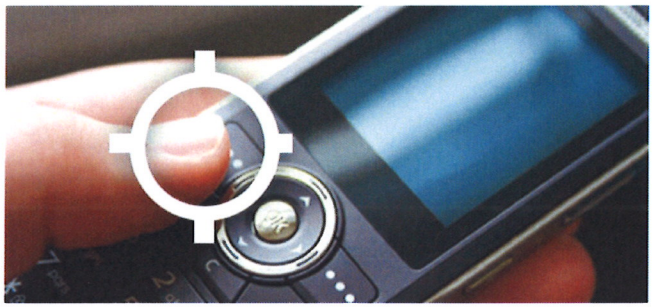
- Providing biometric security (for example, to control access to secure areas or systems)
- Identifying amnesia victims and unknown deceased (such as victims of major disasters, if their fingerprints are on file)
- Conducting background checks (including applications for government employment, defense security clearance, concealed weapon permits, etc.).



Fingerprints are especially important in the criminal justice realm. Investigators and analysts can compare unknown prints collected from a crime scene to the known prints of victims, witnesses and potential suspects to assist in criminal cases. For example:

- A killer may leave their fingerprints on the suspected murder weapon
- A bank robber's fingerprints may be found on a robbery note
- In an assault case, the perpetrator may have left fingerprints on the victim's skin
- A burglar may leave fingerprints on a broken window pane
- A thief's fingerprints may be found on a safe

In addition, fingerprints can link a perpetrator to other unsolved crimes if investigators have reason to compare them, or if prints from an unsolved crime turn up as a match during a database search. Sometimes these unknown prints linking multiple crimes can help investigators piece together enough information to zero in on the culprit.



In the absence of DNA, fingerprints are used by the criminal justice system to verify a convicted offender's identity and track their previous arrests and convictions, criminal tendencies, known associates and other useful information. Officers of the court can also use these records to help make decisions regarding a criminal's sentence, probation, parole or pardon.

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How It's Done

Where Fingerprints May be Found

Fingerprints can be found on practically any solid surface, including the human body. Analysts classify fingerprints into three categories according to the type of surface on which they are found and whether they are visible or not: Fingerprints on soft surfaces (such as soap, wax, wet paint, fresh caulk, etc.) are likely to be three-dimensional plastic prints; those on hard surfaces are either patent (visible) or latent (invisible) prints. Visible prints are formed when blood, dirt, ink, paint, etc., is transferred from a finger or thumb to a surface. Patent prints can be found on a wide variety of surfaces: smooth or rough, porous (such as paper, cloth or wood) or nonporous (such as metal, glass or plastic).

Latent prints are formed when the body's natural oils and sweat on the skin are deposited onto another surface. Latent prints can be found on a variety of surfaces; however, they are not readily visible and detection often requires the use of fingerprint powders, chemical reagents or alternate light sources. Generally speaking, the smoother and less porous a surface is, the greater the potential that any latent prints present can be found and developed.

Collecting Patent Prints

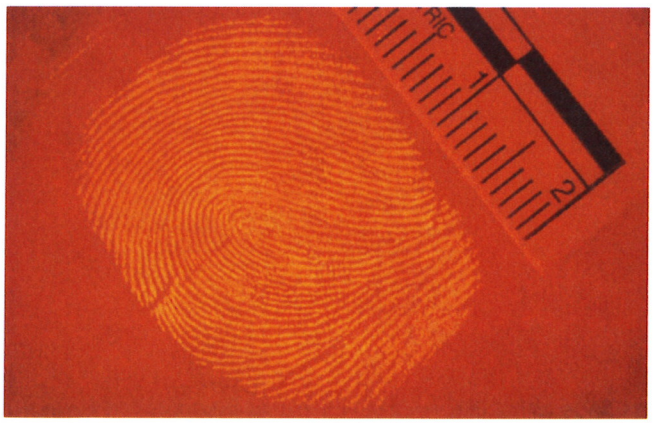
Patent prints are collected using a fairly straightforward method: photography. These prints are photographed in high resolution with a forensic measurement scale in the image for reference. Investigators can improve the quality of the images by using low-angle or alternate light sources and/or certain chemicals or dyes during photography, but this is usually not necessary.

Collecting Latent Prints

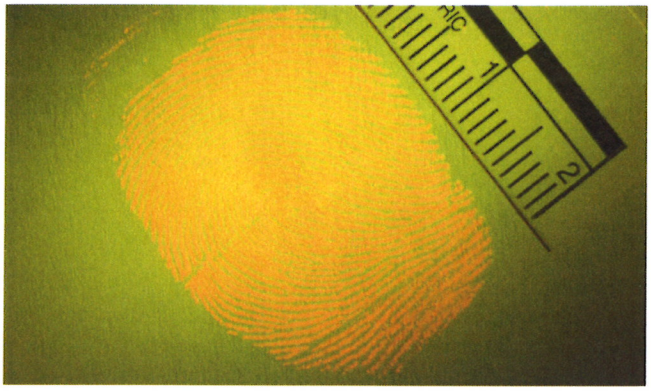
One of the most common methods for discovering and collecting latent fingerprints is by dusting a smooth or nonporous surface with fingerprint powder (black granular, aluminum flake, black magnetic, etc.). If any prints appear, they are photographed as mentioned above and then lifted from the surface with clear adhesive tape. The lifting tape is then placed on a latent lift card to preserve the print.

However, fingerprint powders can contaminate the evidence and ruin the opportunity to perform other techniques that could turn up a hidden print or additional information. Therefore, investigators may examine the area with an alternate light source or apply cyanoacrylate (super glue) before using powders.

Alternate Light Source (ALS): It is becoming more commonplace for investigators to examine any likely surfaces (doors, doorknobs, windows, railings, etc.) with an alternate light source. These are laser or LED devices that emit a particular wavelength, or spectrum, of light. Some devices have different filters to provide a variety of spectra that can be photographed or further processed with powders or dye stains. For example, investigators may use a blue light with an orange filter to find latent prints on desks, chairs, computer equipment or other objects at the scene of a break-in.



Using a fluorescent dye stain and an orange alternate light source helps this latent print appear clearly so that it can be documented. (Courtesy of Scott Campbell, Ron Smith & Associates)



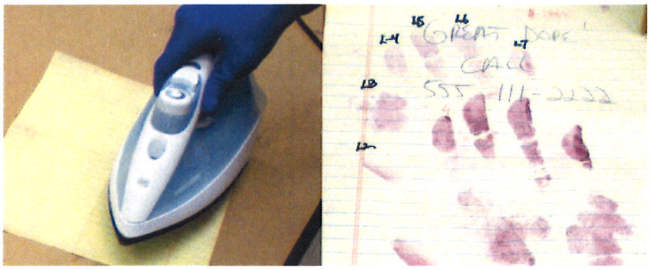
Use of various alternate light sources may help enhance the appearance of a fingerprint. (Courtesy of Scott Campbell, Ron Smith & Associates)

Cyanoacrylate: Investigators often perform cyanoacrylate (superglue) processing, or fuming, of a surface before applying powders or dye stains. This process, typically performed on non-porous surfaces, involves exposing the object to cyanoacrylate vapors. The vapors (fumes) will adhere to any prints present on the object allowing them to be viewed with oblique ambient light or a white light source.

A chamber specially designed for exposing latent prints to super glue fumes. (Courtesy of Scott Campbell, Ron Smith & Associates)

Super glue fumes adhere to latent fingerprints on the neck of a glass bottle. (Courtesy of Scott Campbell, Ron Smith & Associates)

Chemical Developers: Porous surfaces such as paper are typically processed with chemicals, including ninhydrin and physical developer, to reveal latent fingerprints. These chemicals react with specific components of latent print residue, such as amino acids and inorganic salts. Ninhydrin causes prints to turn a purple color, which makes them easily photographed. DFO (1,2-diazafluoren-9-one) is another chemical used to locate latent fingerprints on porous surfaces; it causes fingerprints to fluoresce, or glow, when they are illuminated by blue-green light.



Paper treated with ninhydrin reagent reveals latent prints after being processed with a household steam iron. (Courtesy of NFSTC)

Other Collection Methods: In addition to the methods identified above, there are special techniques for capturing prints from skin, clothing and other difficult surfaces. Amido Black, a non-specific protein stain that reacts with any protein present, is typically used for developing or enhancing bloody impressions on human skin. To reveal prints on clothing, high-tech methods such as vacuum metal deposition using gold and zinc are showing promise for the investigator. AccuTrans®, a liquid casting compound, can be used to lift powdered latent prints from rough, textured or curved surfaces. AccuTrans® is basically a very thick liquid that fills in the nooks and crannies of rough or textured areas where conventional print lifting tape encounters difficulty.

Like fingerprint powders, chemical processing can reduce the investigator's ability to perform other techniques that could reveal valuable information. Therefore, any nondestructive investigations are performed before the evidence is treated with chemicals. For example, a ransom or hold-up note will be examined by a questioned documents expert before being treated with ninhydrin, since some formulations of ninhydrin will cause certain inks to run, thus destroying the writing.

Who Conducts the Analysis

In criminal justice cases, computerized systems are used to search various local, state and national fingerprint databases for potential matches. Many of these systems provide a value indicating how close the match is, based on the algorithm used to perform the search. Fingerprint examiners then review the potential matches and make a final determination.

Fingerprint examinations may be conducted by forensic scientists, technicians or police officers; however, the examiner should have the proper training and experience to perform the task. Currently many agencies require new examiners to have a four-year degree in science (biology, chemistry or physics). In addition, agencies may require examiners to become certified by the International Association for Identification (IAI). IAI's website (http://www.theiai.org) provides certification requirements.

How and Where the Analysis is Performed

Fingerprint analysis is usually performed by law enforcement agencies or crime laboratories; however, casework may be sent to private companies if there is a need, such as to reduce backlogs, verify results, or handle high-profile cases.

Fingerprint examination involves looking at the quality and quantity of information in order to find agreement or disagreement between the unknown print (from the crime scene) and known prints on file. To conduct the examination, fingerprint examiners use a small magnifier called a loupe to view minute details (minutiae) of a print. A pointer called a ridge counter is used to count the friction ridges.

An examiner uses a loupe to view minute details of a fingerprint. (Courtesy of NFSTC)

The Fingerprint Analysis Process

Fingerprint examiners use the ACE-V (analysis, comparison, evaluation and verification) method to reach a determination on each print.

Analysis involves assessing a print to determine if it can be used for a comparison. If the print is not suitable for comparison because of inadequate quality or quantity of features, the examination ends and the print is reported as not suitable. If the print is suitable, the analysis indicates the features to be used in the comparison and their tolerances (the amount of variation that will be accepted). The analysis may also uncover physical features such as recurves, deltas, creases and scars that help indicate where to begin the comparison.

Comparisons are performed by an analyst who views the known and suspect prints side-by-side. The analyst compares minutiae characteristics and locations to determine if they match. Known prints are often collected from persons of interest, victims, others present at the scene or through a search of one or more fingerprint databases such as the FBI's Integrated Automated Fingerprint Identification System (IAFIS). IAFIS is the largest fingerprint database in the world and, as of June 2012, held more than 72 million print records from criminals, military personnel, government employees and other civilian employees.

Evaluation is where the examiner ultimately decides if the prints are from the same source (identification or individualization), different sources (exclusion) or is inconclusive. Inconclusive results may be due to poor quality samples, lack of comparable areas, or insufficient number of corresponding or dissimilar features to be certain.

Verification is when another examiner independently analyzes, compares and evaluates the prints to either support or refute the conclusions of the original examiner. The examiner may also verify the suitability of determinations made in the analysis phase.

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Common Terms

The Scientific Working Group on Friction Ridge Analysis, Study and Technology (SWGFAST) maintains a list of terms generally used and accepted within the fingerprint analysis community. Additional terms can be found on the SWGFAST website (http://www.swgfast.org/documents/glossary/090508_Glossary_2.0.pdf) .

Arch, plain - A type of print pattern in which the friction ridges enter on one side of the print and flow out the other side with a rise or wave in the center.

Arch, tented - A type of print pattern similar to the plain arch but that possesses an angle, upthrust (central rise), or two of the three basic characteristics of the loop.

Cyanoacrylate - The primary (>98%) component of super glue; it is used in a fuming technique to develop latent (invisible) prints on a variety of surfaces so they can be photographed.

Core - A structure in the print that is the center line or lines of the print; it is important for conducting ridge counts.

Delta - A point in loop and whorl prints that lies within an often triangular, three-pronged or funnel-shaped structure; it is the part of a ridge nearest the point where two parallel ridge lines (the "type" lines) diverge to flow around the loop or whorl; loop patterns have one delta, which is the starting point for conducting a ridge count, and whorls have two or more, which are important for determining the whorl type.

Friction ridge - The raised portion of the skin of the print, consisting of one or more connected ridges.

Furrow - A valley or depression between friction ridges.

Loop - A type of print pattern in which one or more friction ridges enter on one side of the print, curve up and around and back down, then flow out on the same side of the print from which it entered; types can be divided into left slant loops and right slant loops or, if the source of the print is known to be a specific hand (the left or right), into radial loops (the pattern flows in the direction of the radius bone of the forearm, toward the thumb) and ulnar loops (the pattern flows in the direction of the ulna bone of the forearm, toward the little finger).

Loupe - A small, often frame-mounted magnifier used for examining fingerprint detail.

Print - The mark made by a finger or thumb on a surface or in a soft material such as wax or wet paint; can be patent (surface-visible), latent (surface-invisible), or plastic (3-dimensional in soft material).

Ridge counter - A handheld, pointed tool used for counting the number of ridges during fingerprint analysis.

Shoulder - The point of a loop's recurving ridge where it curves back around.

Whorl, accidental - A type of print pattern consisting of the combination of two different types of patterns (excluding the plain arch) with two or more deltas; or a print pattern type that possesses some of the requirements for two or more different types of patterns; or a print pattern type that conforms to none of the definitions of a pattern.

Whorl, central pocket loop - A type of print pattern that has two deltas and at least one friction ridge that makes one complete circuit, which may be spiral, oval, circular, or any variant of a circle; an imaginary line drawn between the two deltas does not touch or cross the "central pocket" (the recurving ridges within the inner pattern area).

Whorl, double loop - A type of print pattern that consists of two separate loop formations with two separate and distinct sets of shoulders and two deltas.

Whorl, plain - A type of print pattern that consists of one or more friction ridges making a complete circuit and two deltas; an imaginary line drawn between the two deltas touches or crosses at least one recurving ridge within the inner pattern area.

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